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PATENT SPECIFICATION

1,077,533

1,077,533

Date of Application and filing Complete Specification: July 14, 1964. No. 28941/64

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Application made in Japan (No. 56226) on July 27, 1963.
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Application made in Japan (No. 55156) on October 14, 1963.
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Int. Cl.:—D 01 h // D01b, D03d, D04b, c.

COMPLETE SPECIFICATION

DRAWINGS ATTACHED

Yarn and Fibre containing Synthetic Elastomeric Material and a Process for Manufacturing Fabrics therefrom

We, MITSUBISHI RAYON KABUSHIKI KAISHA, a Body Corporate organized under the Laws of Japan, of 8, 2-chome, Kyobashi, Chuo-ku, Tokyo, Japan, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to a yarn which contains synthetic elastomeric fibres and which is of such a nature as to facilitate the manufacture of fabrics and other goods containing such fibres. The invention also relates to methods of manufacturing fabrics and other goods containing such fibres and to the fabrics and other goods thus manufactured.

According to the invention there is provided a composite yarn containing synthetic elastomeric fibre, formed by combining two constituent filamentary yarns together one of the constituent yarns being composed of a synthetic elastomeric material and the other constituent yarn being composed of water-soluble polyvinyl alcohol and the latter yarn serving for the temporary control of the elasticity of the synthetic elastomeric yarn.

The composite yarns provided by the invention may be used in the manufacture of fabrics or other goods, by weaving, knitting or braiding, the product subsequently being treated with water to dissolve away the polyvinyl alcohol synthetic filaments.

The synthetic elastomeric fibres which may be used in composite yarns in accordance with the invention include polyurethane fibres. As to the polyvinyl alcohol fibres, some such fibres which are available for use in carrying out the invention are soluble in cold water, while others require the use of warm water or water substantially at boiling point.

In cases where the constituent yarns of a composite yarn in accordance with the invention are secured together with adhesive, the adhesive is preferably in the form of a water-soluble bonding agent and the constituent yarns may be bonded together either at spaced positions along their lengths or continuously throughout their lengths. In some cases the constituent yarns referred to above may be combined with natural fibres or with some other synthetic fibres.

Weaving and knitting are facilitated by virtue of the fact that the elasticity of the elastomeric filaments is controlled temporarily, that is to say, during the processes of weaving or knitting; this is achieved by combining the elastomeric fibre with the polyvinyl alcohol yarn since the latter has substantially no elasticity or capability of expanding and contracting as compared with the elastomeric fibre. For the purpose of combining the constituent yarns, it may sometimes be necessary to make use of yarn of natural fibre or of some other synthetic fibre, or some other means may be employed such as sizing of the fibre bundle either through out its length or over sections of the length thereof.

The invention also provides composite staple fibre comprising synthetic elastomeric staple fibre or fibres and water-soluble polyvinyl alcohol synthetic fibre which is of substantially the same length as the said elastomeric fibre or fibres, and which is combined with the synthetic elastomeric fibre or fibres in such a way that the fibres of the two kinds are restrained against relative lengthwise movement, so that the polyvinyl alcohol fibre serves for the temporary control of the elasticity of the elastomeric fibre or fibres.

Mixed spun yarn may be formed by blending such composite staple fibre with another fibre.

The invention also provides a process for manufacturing fabrics or knitted goods comprising knitting or weaving with the above-mentioned composite yarn and treating the product with cold or hot water to eliminate the water-soluble fibre and to leave the knitted or woven water-insoluble fibre structure so as to be suitable for various purposes. In addition, the invention relates to goods thus manufactured and to the secondary products thereof.

Hitherto it has been very difficult to weave or knit yarn of elastomeric synthetic fibres. This is mainly due to the fact that synthetic elastomeric fibre, which may be lengthened to several times, e.g. ten times, its original length during weaving or knitting is quite difficult to control mechanically. This invention makes it possible for this defect to be avoided so that yarn of synthetic elastomeric fibre may be woven or knitted in the same way as yarn of ordinary natural or synthetic fibre.

The objects and advantages of the present invention will be more fully apparent from the following detailed description, given by way of example, only, of certain embodiments of the invention which are illustrated in the accompanying drawings in which:—

Fig. 1 is an enlarged side view of a composite yarn formed by arranging a yarn comprising a synthetic elastomeric filament 1 and a yarn comprising a polyvinyl alcohol synthetic filament 2 in side-by-side relationship.

Fig. 2 is an enlarged view of a yarn made by twining one of the said two kinds of yarns tightly around the other.

Fig. 3 is an enlarged view of a yarn formed by loosely twisting said two kinds of synthetic yarn together.

Fig. 4 is an enlarged view of a yarn formed by twisting and bonding, with a bonding agent 3, the two kinds of constituent yarns shown in Figs. 1 to 3.

Fig. 5 is an enlarged view of a composite yarn made by covering the yarn shown in Fig. 3, which is employed as a core, with fibres 13 of another kind wound around the core.

Fig. 6 shows (in Figs. 6 (4) to 6(6)) various combinations of surface-treated yarn of polyvinyl alcohol synthetic fibre with yarn of synthetic elastomeric fibre; thus:

Fig. 6 (1) is an enlarged view of a yarn of polyvinyl alcohol synthetic fibre 2*a* subjected to a raising or sueding operation, as indicated at 4;

Fig. 6 (2) is an enlarged view of a yarn of polyvinyl alcohol synthetic fibre 2*b* subjected to nonskid treatment as indicated at 5;

Fig. 6 (3) is an enlarged view of a yarn of polyvinyl alcohol synthetic fibre 2*c* the surface of which is given scratches 6;

Fig. 6 (4) is an enlarged view of a composit yarn formed by combining a yarn of synthetic elastomeric fibre 7 with the yarn of polyvinyl alcohol synthetic fibre 2*a* subjected to raising 4;

Fig. 6 (5) is an enlarged view of a yarn made by loosely coiling the nonskid yarn of polyvinyl alcohol synthetic fibre 2*b* around a yarn of synthetic elastomeric fibre 7; and

Fig. 6 (6) is an enlarged view of a yarn formed by loosely twisting a yarn of synthetic elastomeric fibre 7 and the yarn 2*c* of polyvinyl alcohol synthetic fibre which has been subjected to raising 4.

Fig. 7 illustrates the formation of composite staple fibre which can readily be spun:

Fig. 7 (1) is an enlarged longitudinal view of a yarn formed by bonding synthetic elastomeric fibre 1 and water-soluble polyvinyl alcohol synthetic fibre 2 having latent shrinkability with a water-soluble sizing material 3;

Fig. 7 (2) is an enlarged view of a composite yarn formed by loosely coiling water-soluble polyvinyl alcohol synthetic yarn 2 having latent shrinkability around synthetic elastomeric yarn 1 and bonding the constituent yarns with a water-soluble sizing material 3; this form of composite yarn is somewhat similar to that shown in Fig. 4.

Fig. 7 (3) is an enlarged view of a staple fibre obtained by cutting the yarn shown in Fig. 7 (1);

Fig. 7 (4) is an enlarged view of the stapled fibre shown in Fig. 7 (3) when the water-soluble polyvinyl alcohol synthetic fibre having latent shrinkage has been shrunk to cause crimping;

Fig. 7 (5) is an enlarged longitudinal front view of a staple fibre obtained by cutting the yarn of Fig. 7 (2);

Fig. 7 (6) is an enlarged view of the stapled fibre shown in Fig. 7 (5) when the water-soluble polyvinyl alcohol synthetic fibre having latent shrinkability has been shrunk;

Fig. 7 (7) is an enlarged view of a fibre obtained by stapling a yarn formed by bonding with a water-soluble bonding agent 3, synthetic elastomeric fibre or fibres 1 and water-soluble polyvinyl alcohol synthetic fibre 2 having latent shrinkability;

Fig. 7 (8) is an enlarged view of the stapled fibre shown in Fig. 7 (7) when the polyvinyl alcohol synthetic fibre has been shrunk;

Fig. 7 (9) is an explanatory view showing an intermediate stage in mixed spinning of the fibre of Fig. 7 (7) and other fibre 5; in the fibre shown in Figs. 7 (7) and 7 (8), the elastomeric fibre 1 has parts 14 which are adapted to adhere to the other fibre 5, these parts 14 being provided by, for instance the application of spots of water-insoluble bonding ag nt.

Fig. 7 (10) is an enlarged view of the fibre obtained by stapling a yarn as shown in Fig. 7 (2), made by bonding with a water-soluble sizing agent 3, synthetic elastomeric fibre 1 and water-soluble polyvinyl alcohol synthetic fibre 2; in this case also the yarn 1 has parts 14 which are adapted to adhere to other fibre during mixed spinning;

Fig. 7 (11) is an explanatory view showing an intermediate stage in mixed spinning of the staple fibre of Fig. 7 (10) and other fibre 5.

Fig. 8 shows yarn and fabrics containing elastomeric fibre:

Fig. 8 (1) is an enlarged view of a composite yarn A formed by densely coiling a yarn of polyvinyl alcohol synthetic fibre 2 around high-elasticity yarn 1 for control of elasticity;

Fig. 8 (2) shows a fabric G formed by using as warp *a* and filling or weft *b* the yarn A, that is to say, a composite yarn which is made by coiling a water-soluble polyvinyl alchol synthetic yarn 2 around elastomeric yarn 1. The part H of the fabric comprises only elastomeric fibre and is obtained by treating the fabric G with water to dissolve away the yarn 2. The treatment with water also has the effect that the warp and filling or weft of the part H are shrunk and develop a fine crimp 1'.

Fig. 8 (3) shows a fabric made by using as the warp, the yarn A, and also the yarn shown in Fig. 2, which is marked B, while natural fibre yarn 8 is used as the filling or weft. When this fabric is treated with hot water to dissolve the polyvinyl alcohol synthetic fibre, the elastomeric yarn remains as the warp, so that the resulting fabric has a considerable capacity for longitudinal extension and contraction.

Fig. 9 shows knitted fabrics containing elastomeric fibre:

Fig. 9(1) shows a knitted fabric M formed of the yarn shown in Fig. 2, which is made by combining the elastomeric yarn and water-soluble polyvinyl alcohol synthetic yarn. The part N of the fabric comprises only elastomeric fibre, the fabric having been treated with warm or hot water to dissolve away the polyvinyl alcohol synthetic yarn and the remaining elastomeric yarn of the part N displaying a fine crimp 1';

Fig. 9 (2) shows a flat-knitted fabric formed of yarn A as shown in Fig. 8 (1). yarn C as shown in Fig. 2 and ordinary natural or synthetic yarn 8, and when the knitted fabric is treated with warm or hot water to dissolve away the polyvinyl alcohol synthetic yarn, there remains a knitted fabric which is flexible in the longitudinal and lateral directions;

Fig. 9 (3) shows a warp-knitted fabric formed initially of yarn A, yarn B as shown in Fig. 2 and ordinary natural or synthetic yarn 8. This warp-knitted fabric is treated with warm or hot water to dissolve away the polyvinyl alcohol synthetic yarn, leaving warp-knitted fabric made up of the elastomeric yarn and the yarn 8.

Although woven and knitted goods are illustrated as examples of the products, it is to be understood that the principle applies also to such materials as laces and nets.

Polyvinyl alcohol synthetic filament, which is a component of the yarns illustrated in Figures 1, 2 and 3, may be made fine or small in denier owing to the recent development of the dry spinning method. To take an example of the production of such filament, polyvinyl alcohol is dissolved in water and dry-spun and then drawn in air heated at 120 to 200°C., so as to be extended to between twice and nine times the original length; it is then further heat-treated to set it.

The formation of the composite yarns used in carrying the invention into effect has been described with reference to Figures 1, 2 and 3. The properties of these composite yarns will now be further described.

In using the yarns illustrated in Fig. 1, 2 and 3 advantage is taken of the properties of polyvinyl alcohol synthetic filaments, and more particularly of their high water-solubility due to their not being subject to acetal formation. The water-soluble synthetic yarn is suitably combined with the elastomeric yarn, such as by twisting, to control the elongation of the elastomeric yarn, thus making it possible to perform weaving, knitting and other similar operations as easily as is the case with ordinary natural or synthetic fibre.

Woven or knitted goods formed of the aforesaid yarns are treated with water to dissolve away the polyvinyl alcohol synthetic yarn and the elastomeric synthetic yarn is left so as to constitute the end-product. Since with the composite yarns provided by the invention, the elongation of the elastomeric synthetic fibre is temporarily controlled by the polyvinyl alcohol synthetic yarn, these composite yarns are suitable for use with conventional weaving and knitting machines.

The amount of water-soluble polyvinyl alcohol synthetic yarn which is combined with the synthetic elastomeric yarn need not exceed an amount that is just sufficient for temporary control of the elongation of the synthetic elastomeric yarn: therefore, it is usually desirable to use as small an amount as possible of the water-soluble polyvinyl alcohol synthetic yarn for the combination. In addition, lace work can be performed using synthetic elastomeric yarn by either mechanical or chemical processes. When using a chemical process, it is recommended to use water-soluble polyvinyl alcohol synthetic yarn to weave base material and then

to embroider the base material with a pattern using the yarn of the present invention; the polyvinyl alcohol synthetic yarn composing the base material and the polyvinyl alcohol filaments in the yarn of the invention are then simultaneously dissolved in water, thus providing the openings in the lace.

In addition, the use of coloured polyvinyl alcohol synthetic yarn makes it possible to observe clearly the manner in which the latter is combined with the synthetic elastomeric yarn, and this facilitates the operation and enables the solution of the polyvinyl alcohol yarn in water after weaving or knitting, to be readily observed.

In forming the yarn illustrated in Figure 4, just as in the yarns illustrated by Figures 1, 2 and 3, the synthetic elastomeric yarn 1 and the water-soluble polyvinyl alchol synthetic yarn 2 may be loosely twisted and then set with the water-soluble sizing agent 3, or the yarn 2 may be loosely coiled around the yarn 1 as with Fig. 2, and set with the water-soluble sizing agent 3 (see Fig. 7 (2).

In the yarn illustrated by Fig. 5, elastomeric synthetic fibres 1 and water-soluble polyvinyl alcohol synthetic fibres 2 may be combined by twining the yarn 2 loosely around the yarn 1, or twisting the yarns 1 and 2 together, just as in Figs. 2 and 3.

The composite yarns illustrated by Figures 6 (4) to 6 (6) may be formed in such a way that they can be freely wound ready for use in weaving or knitting. The composite yarns shown in these figures are made by combining a yarn of elastomeric synthetic fibre with a yarn of water-soluble polyvinyl alcohol synthetic fibre, the surface of which latter has been raised or subjected to nonskid treatment. If necessary the two yarns can be bonded with a water-soluble sizing agent, for temporaty control of elongation.

The yarn thus formed, as illustrated in Figs. 6 (4) to 6 (6), has its elongation controlled temporarily and also has excellent adherence and holding properties as between the two sorts of fibres composing the yarn, so that no trouble can arise from separation or slipping, while such operations as winding, weaving and knitting are facilitated.

Furthermore, if the yarn of synthetic elastomeric fibre and the yarn of water-soluble polyvinyl alcohol synthetic fibre which has been subjected to raising or nonskid treatment are bonded with a water-soluble sizing material, the adherence and holding properties are heightened with remarkably improved effect.

As is illustrated by Figs. 7 (1) and 7 (2), synthetic elastomeric yarn 1 and water-soluble polyvinyl alchol synthetic yarn 2 may be bonded with a water-soluble sizing agent 3. The two yarns may be combined with the varns 1 and 2, parallel as shown in Fig. 7 (1) or with one loosely twined around the other as in Fig. 7 (2) or with mutual twisting of the two yarns as in Fig. 4. The composite yarn may then be cut into short lengths. In each of the staple fibres shown in Figs. 7 (3) and 7 (5), the elastomeric synthetic fibre is intimately combined with the water-soluble polyvinyl alcohol synthetic fibre 2 which has latent shrinkability; therefore, when the constituent yarn 2 is shrunk to cause crimping, the whole of the staple fibre is crimped in three dimensions as shown in Figs. 7 (4) and 7 (6).

Water-soluble polyvinyl alcohol synthetic fibre having latent shrinkability for this purpose can be produced by adequate selection of the processing conditions, such as the original liquor, the spinning, the extending or the heat treatment.

Blending of the staple fibre of this example with, for example, staple of another fibre may be performed after crimping, but usually it is convenient to perform blending in the uncrimped state shown in Figs. 7 (3) and 7 (5) and then to cause crimping by heat treatment, this being accompanied by improved spinnability and ease of operation.

In the staple fibre illustrated in Fig. 7, because of the content of polyvinyl alcohol synthetic fibre, the elongation of the synthetic elastomeric fibre is controlled temporarily, so that no extension of the staple fibres occur during the processing. Therefore, the yarn can be spun by the same process as other fibres. In addition, owing to the shrinkage undergone by the polyvinyl alcohol synthetic fibre which have latent shrinkability (including crimpability), the whole fibre is formed so as to have three-dimensional crimping, thus being characterised by great improvement in its capacity for combining with other fibres.

The spun yarn obtained by spinning this staple fibre is finally treated with water so that the polyvinyl alcohol synthetic fibre is dissolved away. If, as a result of this operation only a part of the polyvinyl alcohol fibre is dissolved, the residual polyvinyl alcohol acts as a bonding agent which will cause the elastomeric constituent yarn to stick partially to some other fibre if desired, so that a crimpable spun yarn is obtained which has elastomeric properties as a whole.

As already mentioned Fig. 7 (7) shows staple in which elastomeric fibre fibres having a plurality of spot-adhering parts 14 are bonded with water-soluble polyvinyl alcohol synthetic fibre 2 having latent shrinkability (including crimpability) and having approximately the same length as the fibres 1. Bonding is effected with a water-soluble sizing agent 3. When crimping is caused, a fibre crimped in three dimensions as shown in Fig. 7 (8) is formed. If the staple fibre of Fig. 7 (7) is blended with another staple fibre and, after crimping, the polyvinyl alcohol

synthetic fibre is dissolved away, the other fibre 5 and the elastomeric fibre or fibres 1 are left entangled with one another and also attached at the spot-adhering parts 14; accordingly, the properties of the elastomeric fibre 1 contribute greatly to the properties of the spun yarn as a whole.

The spot-adhering points 14 may be few or many, according to the desired degree of crimping. The water-soluble polyvinyl alcohol synthetic fibre and shown in Fig. 7 (10), has substantially no latent shrinkability. Since the elastomeric fibre has spot adhering parts 14, it sticks to the other fibres 5 at the spot-adhering parts 14, as shown in Fig. 7 (11), after the polyvinyl alcohol synthetic fibre has been dissolved. Consequently, the spun yarn thus produced has high elasticity. The bonding agent for use at the spot-adhering parts need not be more particularly specified but usually a water-insoluble bonding agent is preferable, and it is convenient for the adhesive effect to be adjustable according to temperature differences.

The staple fibres described with reference to Fig. 7 make it readily possible to produce elastomeric blended yarn, which has been regarded hitherto as difficult; the use of this staple fibre makes possible blending with other fibre and, further, the production of special blended yarn.

In the yarn illustrated by Fig. 8 (1) the continuous fibre 2 used for coiling not only acts to protect and reinforce the core comprising the synthetic elastomeric yarn 1, but also serves to suitably adjust, in accordance with the degree of coiling, the extensibility of the synthetic elastomeric yarn.

Fig. 8 (2) has already been sufficiently described. As already mentioned, Fig. 8 (3) shows a fabric formed by using as warp the yarn A (made by coiling a yarn of water-soluble polyvinyl alcohol synthetic fibre around a yarn of elastomeric synthetic fibre and, if necessary, bonding the two constituent yarns with a sizing agent and the yarn B (made by twining a yarn of water-soluble polyvinyl alcohol synthetic fibre around a yarn of synthetic elastomeric fibre as shown in Fig. 2 and, if necessary, bonding the two yarns with a sizing agent for temporary control of elongation). Natural fibre or synthetic fibre of relatively low elasticity may be used as filling or weft 8. Alternatively, either or both of the above-mentioned yarns A and B may be used as filling or weft also. The fabric or product thus obtained is treated with water at 98 to 100°C. so as to dissolve away the polyvinyl alcohol synthetic fibre. The material remaining is composed of the elastomeric yarn and any other non-soluble yarn which has been employed and the fabric as a whole displays elastomeric properties.

With this form of yarn, not only is the weaving process easy because as long as the elasticity of the elastomeric synthetic fibre is temporarily controlled by the water-soluble polyvinyl alcohol synthetic yarn the elastomeric yarn cannot extend, but also, since the manufacturing conditions of the constituent yarns can be suitably adjusted, production of elastomeric yarn the finished surface of which is aesthetically pleasing is ensured. Moreover, the overall elasticity of the fabric produced is determined mainly by the elastic properties of the synthetic elastomeric yarn, the manner in which the yarns are constituted and combined and the manner in which the yarns are arranged in the warp and weft directions. It it also to be recommended that woven articles should be produced from the fabrics as woven from the yarns of the invention and that the woven articles shall be treated with water, rather than that the fabrics should be treated before manufacture into articles.

When the fabric or fibre product of this example is treated with water to dissolve away the polyvinyl alcohol synthetic yarn, the product as a whole is rendered elastomeric.

In this example, the texture of the fabric is not limited, and accordingly can be chosen out of various textures and may contain another kind of yarn.

The formation of the knitted goods illustrated by Fig. 9 can be performed similarly to the weaving of the fabrics illustrated in Fig. 8, by feeding a knitting machine with any of the yarns described hereinbefore, together with other yarn which is added to or combined with the former yarn. The knitted materials shown in Fig. 9 have already been sufficiently described.

The knitted material illustrated by Fig. 9 may be used advantageously for the flexible parts of socks, gloves, and other knitted products. The texture of this knitted material is not limited, and some other kind of yarn may be mixed in or added thereto, or the yarn of the invention may be added to other kinds of fibre. In this way, knitted materials with various patterns are obtainable. In this case also it is possible to provide elastomeric products by manufacturing goods from the knitted material and then treating the goods with warm or hot water, after manufacture.

WHAT WE CLAIM IS:—

1. A composite yarn containing synthetic elastomeric fibre, formed by combining two constituent filamentary yarns together, one of the constituent yarns being composed of a synthetic elastomeric material and the other constituent yarn being composed of water-soluble polyvinyl alcohol and the latter yarn serving for the temporary control of the elasticity of the synthetic elastomeric yarn.

2. A composite yarn as claimed in claim

1, wherein the constituent yarns are twisted or twin d together.

3. A composite yarn as claimed in claim 1 or claim 2, wherein the surface of at least one of the constituent yarns is scratched or otherwise roughened so as to restrain relative movement of the two constituent yarns.

4. A composite yarn as claimed in any one of the preceding claims, wherein the constituent yarns are secured together with adhesive.

5. A composite yarn as claimed in any one of the preceding claims, wherein the combined constituent yarns are covered spirally with a yarn of natural fibre or of another synthetic fibre, the latter yarn serving for temporary control of overall elongation.

6. A composite yarn as claimed in claim 4, wherein a water-soluble sizing agent is used as adhesive for securing together the two said constituent yarns.

7. Composite staple fibre comprising synthetic elastomeric staple fibre or fibres and water-soluble polyvinyl alcohol synthetic fibre which is of substantially the same length as the said elastomeric fibre or fibres, and which is combined with the synthetic elastomeric fibre or fibres in such a way that the fibres of the two kinds are restrained against relative lengthwise movement, so that the polyvinyl alcohol fibre serves for the temporary control of the elasticity of the elastomeric fibre or fibres.

8. Composite staple fibre as claimed in claim 7, where in the polyvinyl alcohol fibre possesses latent shrinkability.

9. Composite staple fibre made by stapling a composite yarn as claimed in claim 4 or claim 6 or claim 5 as appendent to claim 4.

10. Composite staple fibre substantially as hereinbefore described with reference to and as shown in the accompanying drawings.

11. A yarn made by spinning composite staple fibre as claimed in any one of claims 7 to 10.

12. A composite yarn substantially as hereinbefore described with reference to and as shown in the accompanying drawings.

13. A process for manufacturing fabrics or other goods comprising weaving, knitting or braiding with a composite yarn as claimed in any one of claims 1 to 6, 11 and 12 and treating the product with water to dissolve away the polyvinyl alcohol.

14. A process for manufacturing fabrics or other goods substantially as hereinbefore described with reference to and as illustrated by the accompanying drawings.

15. A method of manufacturing a woven, knitted or braided article, comprising forming a fabric by weaving, knitting or braiding with a composite yarn as claimed in any one of claims 1 to 6, 11 and 12, making an article from the fabric thus formed and treating the article with water to dissolve away the polyvinyl alcohol.

16. A method of manufacturing a woven, knitted or braided article, substantially as hereinbefore described with reference to and as illustrated by the accompanying drawings.

17. A fabric whenever manufactured by a process as claimed in claim 13 or claim 14

18. An article whenever manufactured by a method as claimed in claim 15 or claim 16.

Agents for the Applicants,
STANLEY POPPLEWELL FRANCIS & ROSS,
Chartered Patent Agents,
Cursitor House,
9-11, Cursitor Street,
London, E.C.4.

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FIG. 1

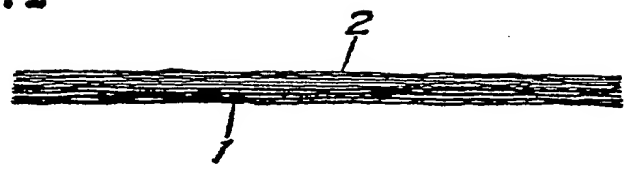


FIG. 2

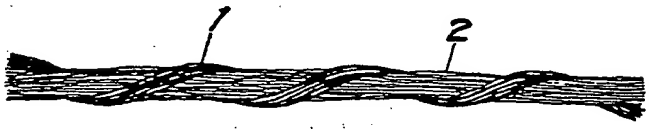


FIG. 3

FIG. 4

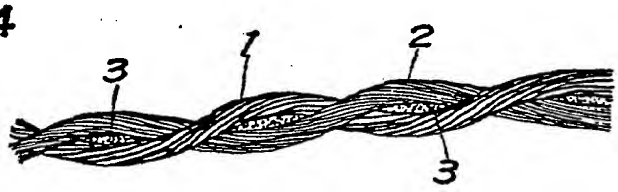
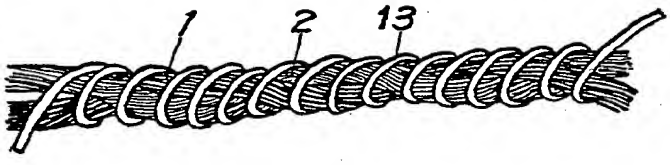


FIG. 5



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7 SHEETS

COMPLETE SPECIFICATION

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FIG. 6

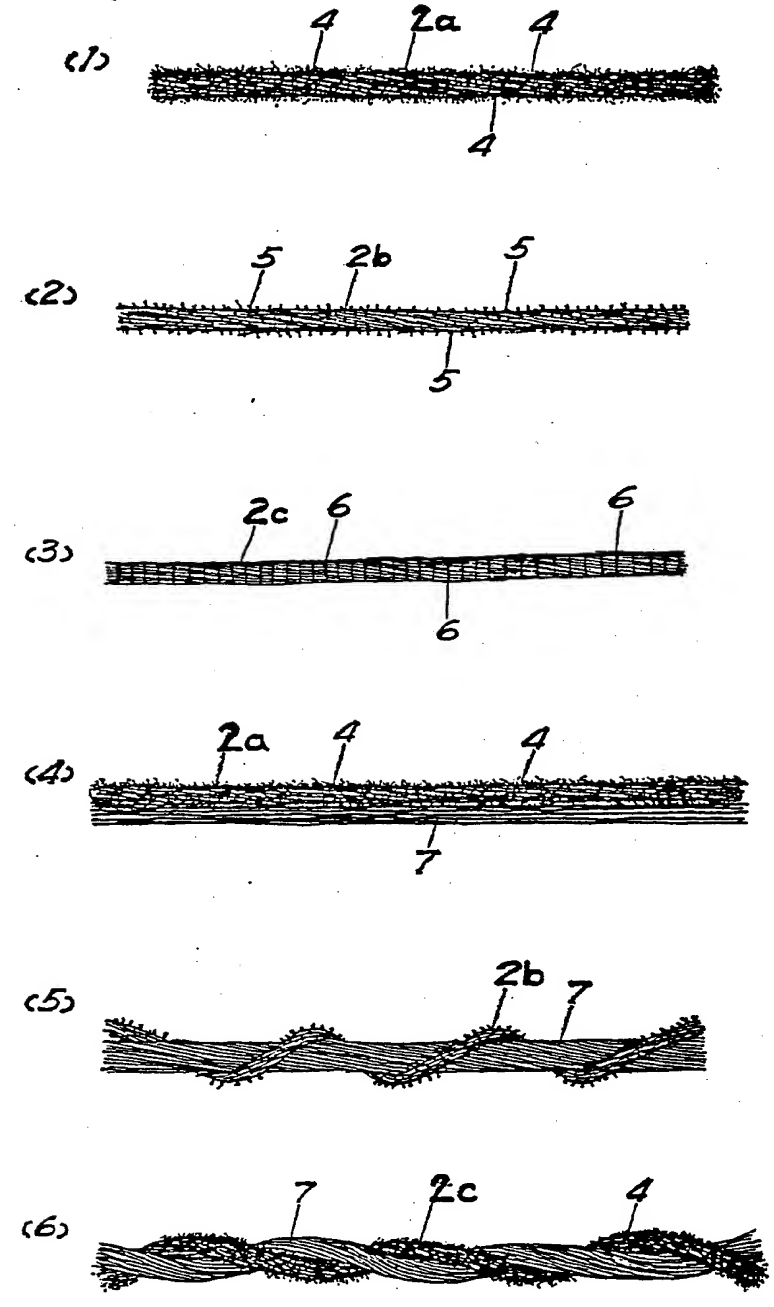

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FIG. 1

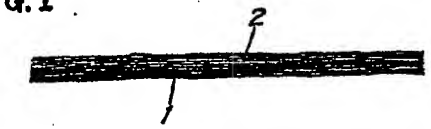

FIG. 2

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FIG. 4

FIG. 5

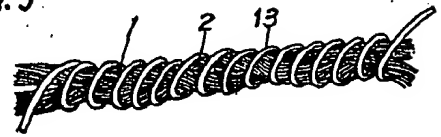

FIG. 6

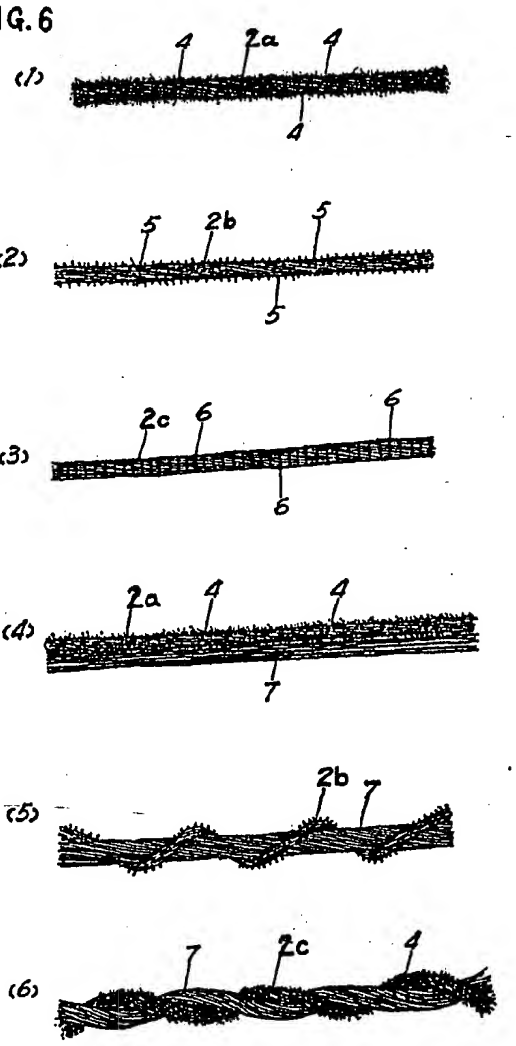

FIG. 7

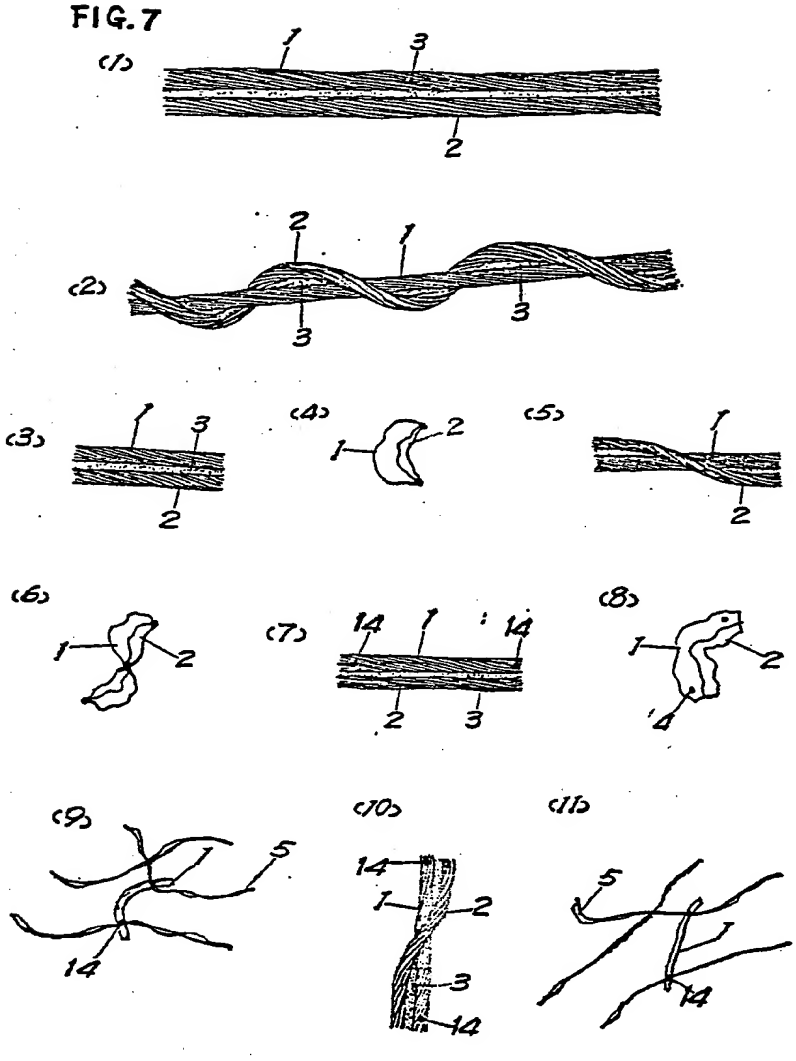
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FIG.8

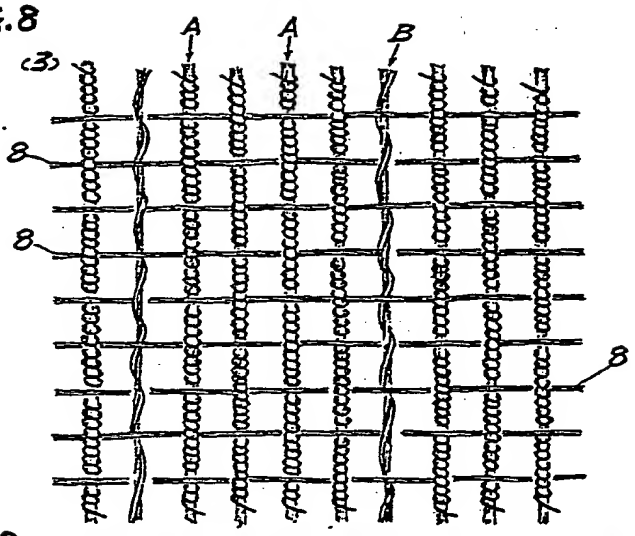
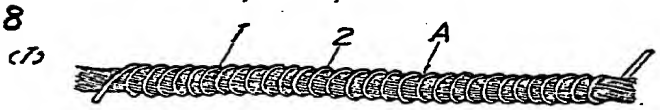
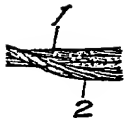
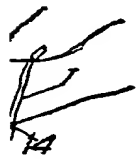
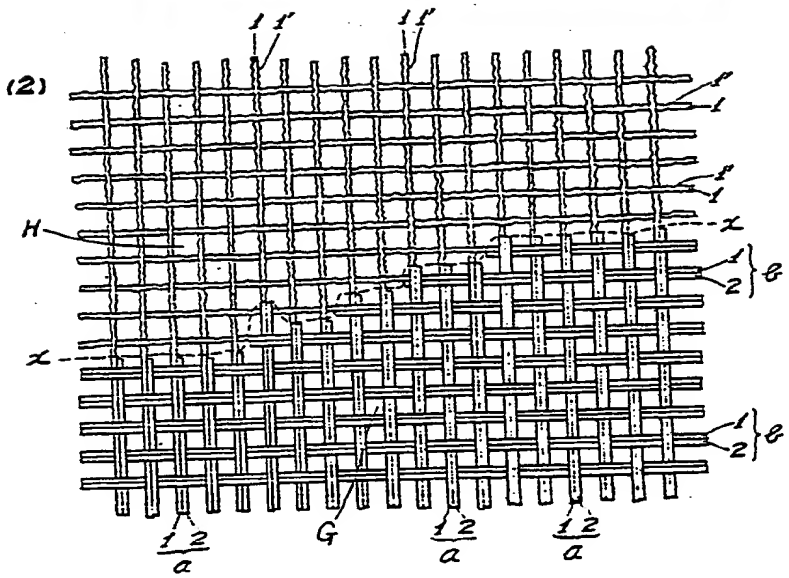


FIG.8









1077533 COMPLETE SPECIFICATION
7 SHEETS This drawing is a reproduction of the Original on a reduced scale
Sheets 3, 4 & 5

FIG.7

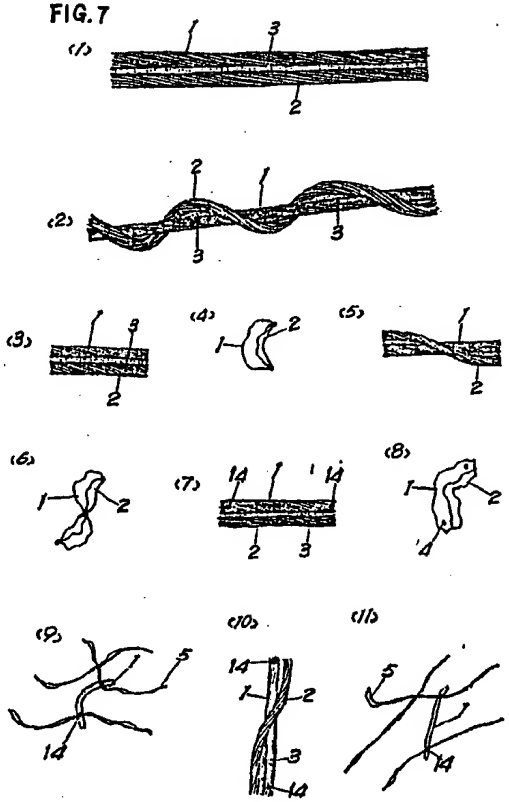


FIG.8

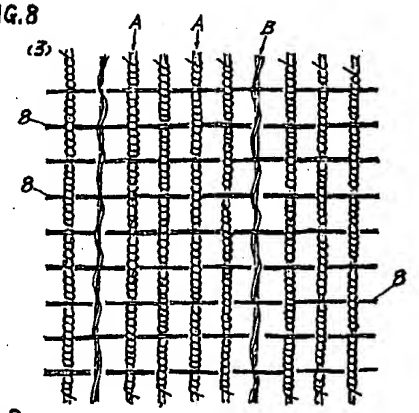


FIG.8

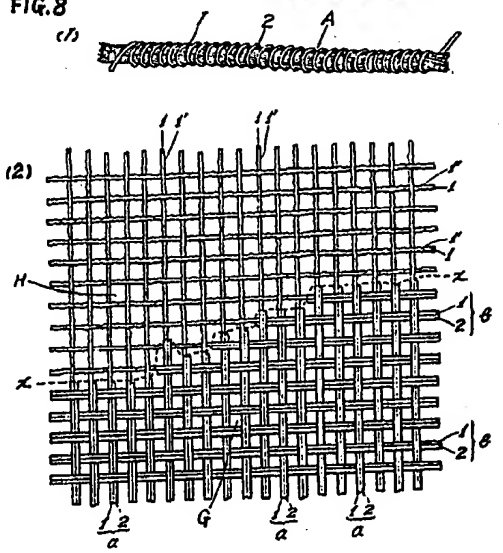
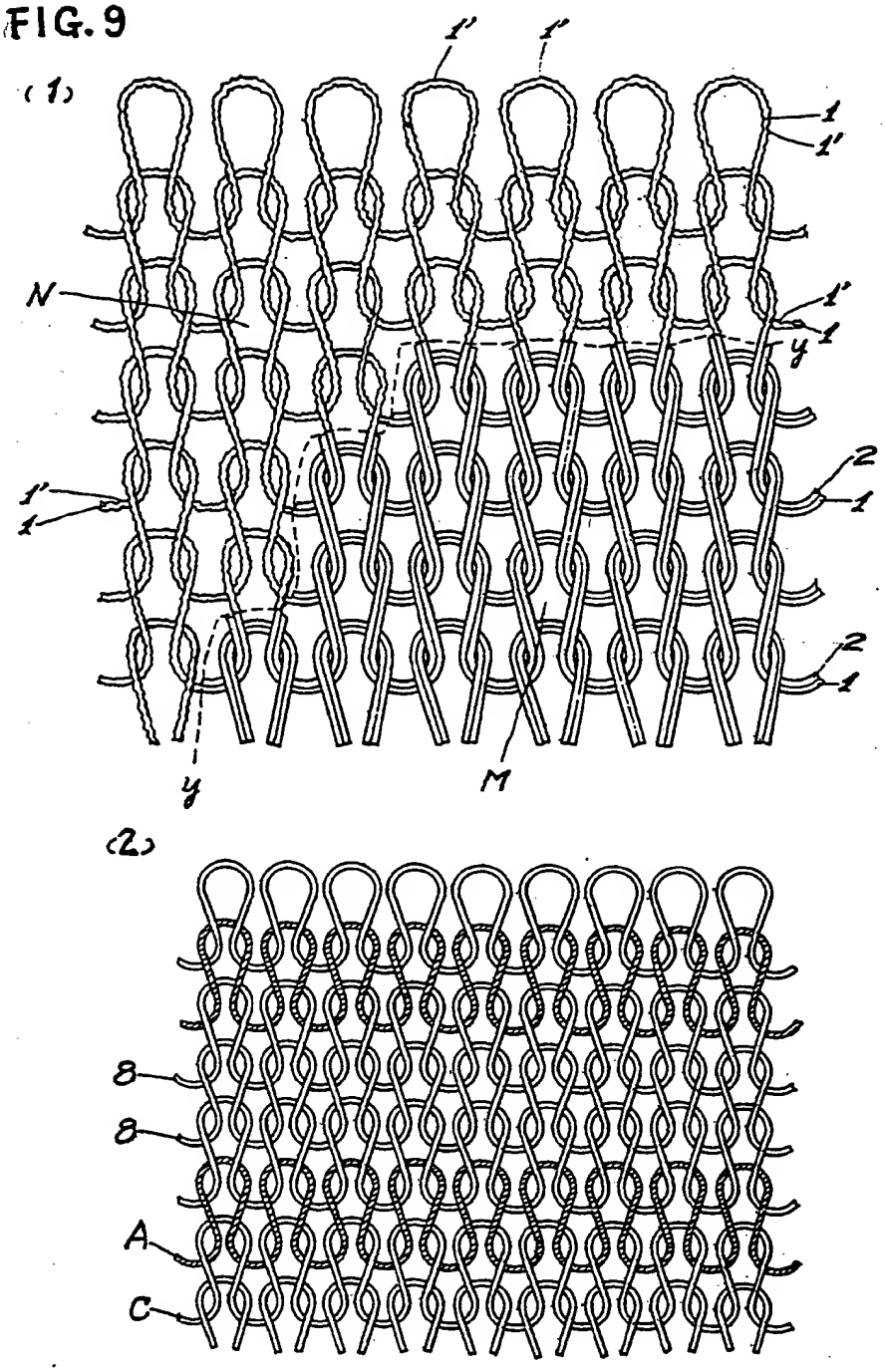


FIG. 9



1,077,533
7 SHEETS

COMPLETE SPECIFICATION

This drawing is a reproduction of the Original on a reduced scale.
SHEETS 6 & 7

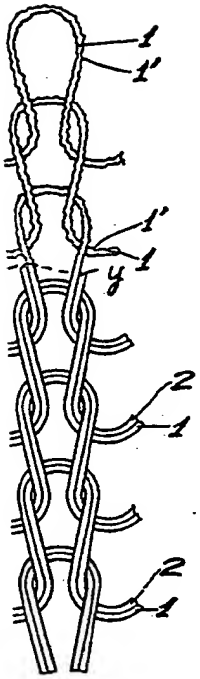
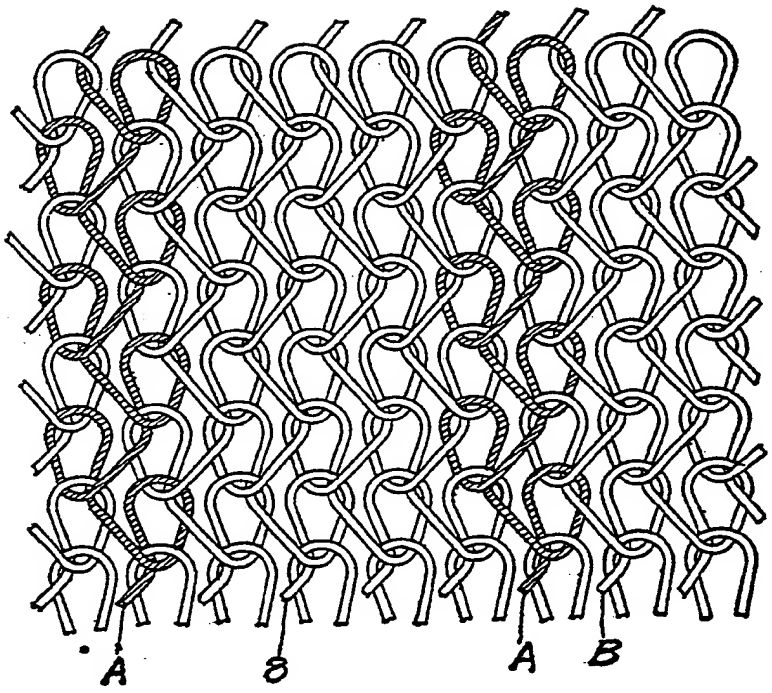
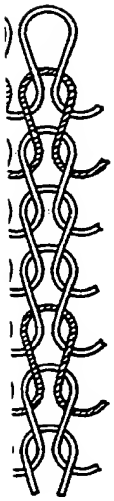


FIG. 9

(3)





1,077,533 COMPLETE SPECIFICATION
7 SHEETS This drawing is a reproduction of the Original on a reduced scale.
SHEETS 6 & 7

FIG. 9

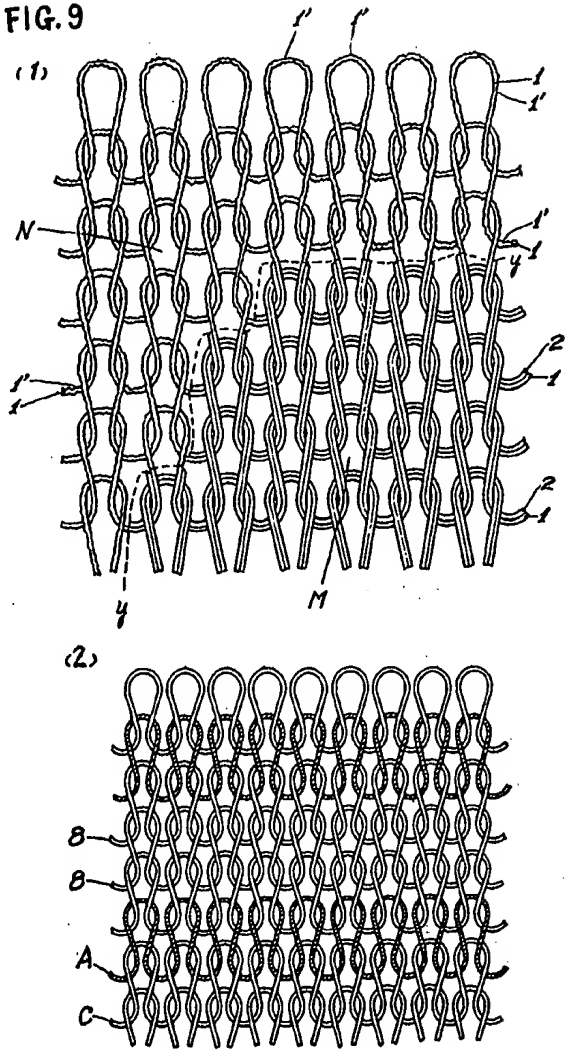


FIG. 9